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# Silver Capped Silicon Nanopillars as Surface Enhanced Raman Spectroscopy Substrates

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**Abstract**— In order to achieve widespread use in practical applications, a Surface-enhanced Raman Scattering (SERS) substrate should possess (i) a compatibility with high volume manufacturing process flows (ii) high and reproducible enhancement factors (EF), i.e., enhancement uniformity, over large surface areas and (iii) a tunable localized surface plasmon resonance (LSPR) wavelength over a broad spectral region. Using a novel lithography free reactive ion etch process, we fabricate wafer-scale silicon nanopillars with a high aspect ratio and subsequently coat them with silver by electron beam evaporation [1] to form plasmon supporting structures. The fabricated pillars (Fig. 1(a)) are flexible and will lean towards their nearest neighbors as the deposited analyte solution evaporates, creating self-assembled SERS hot spots at which the analyte molecules are exactly located. The fabrication method has been optimized with an emphasis on improving the SERS signal-to-noise ratio, to realize molecular detection at ultra-low concentrations [2]. The employed etching process is wafer-scale, and since it does not require any lithographic step, is fast and repeatable, thus allowing the produced substrates to be used as cheap and expendable consumables. Additionally, the produced substrate exhibits a highly uniform EF across a large area (Fig. 1(b)). It also displays a broad LSPR band (Fig. 1(c)), enabling SERS sensing at various excitation wavelengths. In the hot-spots in-between the pillars, strong localized fields are generated by the hybridized LSPR modes and the cavity LSPR mode (Fig. 1(d)). This presentation will highlight the key features of this SERS substrate and give examples of sensing applications.

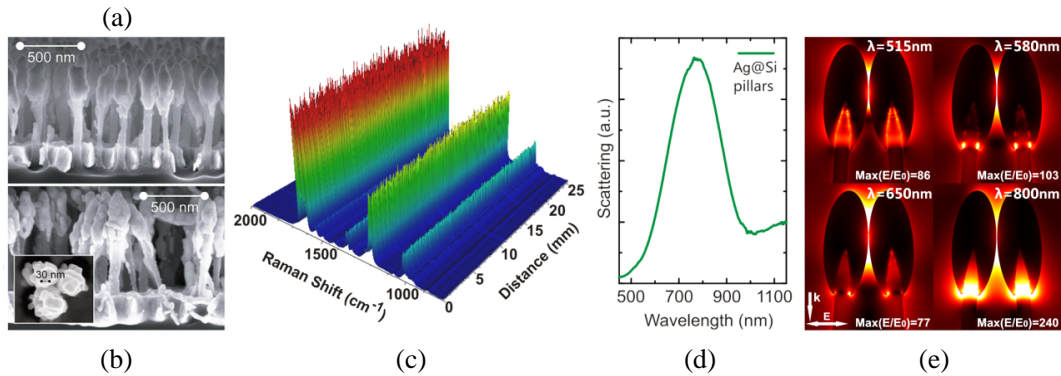


Figure 1: (a), (b) SEM images of the Ag@Si nanopillars (a) before and (b) after leaning. (b) Mapped SERS spectra of 10 mM trans-1,2-bis (4-pyridyl) ethylene in ethanol solution under 780 nm excitations. (c) Measured scattering spectrum of the Ag@Si nanopillar substrate. (d) Simulated cross-sectional electric field EF distributions for a dimer of Ag@Si nanopillars at different excitation wavelengths.

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